

# Exploration Flight Test 1 Afterbody Aerothermal Environment Reconstruction

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**The Exploration Flight Test 1 vehicle included roughly 100 near surface thermocouples on the after body of the vehicle. The temperature traces at each of these instruments have been used to perform inverse environment reconstruction to determine the aerothermal environment experienced during re-entry of the vehicle. This paper provides an overview of the reconstructed environments and identifies critical aspects of the environment. These critical aspects include transition and reaction control system jet influence. A blind test of the process and reconstruction tool was also performed to build confidence in the reconstructed environments. Finally, an uncertainty quantification analysis was also performed to identify the impact of each of the uncertainties on the reconstructed environments.**

## I. Introduction

The Orion Multi Purpose Crew Vehicle (MPCV) is NASA's next generation human space exploration system. The geometry is similar to that of Apollo, though larger in diameter. It has been designed to carry up to four astronauts and capable of Earth entries from beyond Low Earth Orbit (LEO). The Exploration Flight Test 1 (EFT-1) mission was launched on December 5th, 2014 from Kennedy Space Center on a Delta 4 heavy launch vehicle. The vehicle orbited the Earth twice before re-entering the atmosphere at roughly 8.5 km/s and ultimately splashing down in the Pacific Ocean west of Mexico.

The vehicle included roughly 100 thermocouples on the after body of the vehicle. The temperature histories at each of these locations were then used to perform inverse environment reconstruction to determine the aerothermal environments on the vehicle during re-entry. This paper focuses on the process used to perform the environment reconstruction and summarizes the environments in the attached and wake regions of the after body, as well as the base region. The impact of transition and reaction control system jet firings as well as cavities and other vehicle features will be identified, though in-depth analysis of these phenomena will be discussed in other papers.

To help verify and validate the inverse environment reconstruction tools and process, a blind test was performed. The aerothermal design database was used to generate environments at each of the thermocouple locations along an off nominal trajectory. Aspects of the aerothermal design database were also perturbed. These environments were then used to perform direct thermal response modeling to generate predicted in-depth temperature histories at the thermocouples. Aspects of the material stack-up were also perturbed as well as the specific material properties. These temperature histories were then provided to the EFT-1

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environment reconstruction team. The team then perform inverse environment reconstruction with these temperature histories and compared the results to the input environments to help develop confidence in the overall process.

## Proposed Paper

In the final manuscript the authors plan to go into more detail about the process used to reconstruct the environments as well as the results of the blind study performed to develop confidence in the overall process. The reconstructed environments will be discussed in-depth, identifying critical aspects of the environment. Additionally, the uncertainty quantification analysis will be discussed as well as the resulting errors bars on the reconstructed environments will be presented.

## Acknowledgments

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## References

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